workhouses, poor-houses, manufactories, mad-houses, hospitals, schools."*

In the fifth letter, Mr. Bentham desired it to be clearly understood, that "the essence of it (the invention) consists in the *centrality* of the inspector's situation, combined with the well known and most effectual contrivance for *seeing without being seen.*" He mentions the collateral advantage of *frugality* consequent on this plan as to inspectors, a single person being competent to the supervision from a central point, of a greater multitude than were ever yet collected in one building. Another very important advantage of the plan, he states to be, that "the under-keepers, or inspectors, the servants and subordinates of every kind, will be under the same irresistible control with respect to the head keeper or inspector as the prisoners, or other persons to be governed. It presents an answer, and that a satisfactory one, to one of the most puzzling of political questions, *quis custodiet, ipsos custode.*"

In manufactories, he speaks of the central observatory as suitable for the compting-house. His appropriate observations in regard to schools, admit not well of abridgment. One paragraph, however, it may be worth quoting, as indicating the origin of Sir Samuel's invention. Jeremy Bentham says, "In the Royal Military School at Paris, the bed-chambers (if my brother's memory does not deceive him), form two ranges on the two sides of a long room; the inhabitants being separated from one another by partitions, but exposed alike to the view of a master at his walks, by a kind of *grated window* in each door. This plan of construction struck him, he tells me, a good deal, as he walked over that establishment (about a dozen years ago was it not?) with you; and possibly in that walk the foundation was laid for his Inspection House. If he there borrowed his idea, I hope he has not repaid it without interest. You will confess some difference, in point of facility, between a state of incessant walking, and a state of rest; and in point of completeness of inspection, between visiting two or three hundred persons one after another, and seeing them at once."

In the year 1790 the amelioration of prisons and penitentiaries being a subject of public interest, Jeremy Bentham had opportunity of discussing his brother's invention with many influential persons. Sir Samuel, coming soon afterwards to England, had complete models made on his principle of a prison for a thousand persons, in which, as the rays consisted of several floors, the upper ones were appropriated to services requiring the less constant inspection, but were subject to it at all times by means of a counterpoise apparatus affixed to the platform on which was the inspector's chair, so that at pleasure he could raise himself to any required height. Members of Government were highly satisfied with the Panopticon principle itself, with the adaptation of it to the purposes of a penitentiary prison, as exhibited in the model, as well as with Jeremy Bentham's views in regard to the placing the whole, as by contract, in the hands of a private individual, subject to all the checks, and to all the publicity which he had laid down as essential security for the fulfilment of the trust reposed; they consequently authorized Mr. Bentham to make preparations for the erection of such a structure. Sir Samuel contrived the whole with its details so as to be *fireproof*, introducing iron, cast and wrought, in lieu of wood. The site fixed on by Government was Putney Heath, but the thought of having a prison in their neighbourhood was revolting to many who had villas in the vicinity, which caused that place to be given up. Millbank was offered to Mr. Bentham in lieu, but the unhealthiness of the locality rendered him averse to its acceptance; hesitation on both sides led to the abandonment of the project altogether. Great part of the castings had been provided, which, with outlay for machinery of Sir Samuel's invention, contrived for the use of prisoners, had amounted to an expenditure of upwards of 20,000*l*.

Early in 1797, the Admiralty having desired Sir Samuel's opinion (he being then Inspector General of Naval Works) whether the requisite security for 11,000 prisoners of war might not be more economically provided for than by a plan their lordships referred to him, and for which a number of wooden prison-houses were already framed in London, he devised the glazing of one end of these houses, and arranging them radially, pointing to a centre, each prison-house having its airing-ground before it towards the centre. For the guarding these prisons, he devised the construction of a central observatory, wherein the whole of the military requisite would be lodged, so that their force would be concentrated in case of any outbreak amongst the prisoners, and by placing there a small swivel-gun or two, perfect command was obtained over the prison houses. Thus whilst all the prisons were constantly under observance sufficient for security, the prisoners themselves were freed from the annoyance of guards mixing with them. By this Panopticon arrangement, out of the 1,500 officers and men that had been destined as a guard, even as many as a thousand might well have been spared for other services. It proved, however, that sufficient accommodation for prisoners was found elsewhere.

With the knowledge of the British Government, Sir Samuel, in 1804, presented to the Emperor of Russia the design of a Panopticon as a school of arts, combined with a manufactory for a great variety of articles for the naval service. Shortly afterwards, whilst he was on a mission from this Government to that of St. Petersburgh, the Emperor commanded the erection of such a Panopticon there. Its progress was already sufficiently advanced to afford proof of the perfection of the plan, when, in 1807, war having broken out between the two countries, Sir Samuel was recalled. The building was, however, completed, and brought into use. General Fanshawe, Governor-general of the Crimea, having witnessed its advantages, pointed out the superiority of a building on this principle as *barracks*.

For several years the erection of a naval arsenal in the Isle of Grain, or elsewhere to the north of the Forelands, had been in contemplation; but on the abandonment of this measure, the Admiralty signified their pleasure that Sir Samuel should devise means for the improvement of Sheerness Dockyard. After much thought, and impressed, as he had long been, with the need of suitable accommodations for affording supplies and repairs to our fleets to the eastward, particularly for ships of the line, and finding it would be less costly to form a new dockyard on waste ground and headlands than to repair and augment the old one, he, in January, 1812, presented a design for forming a complete arsenal at that port. Existing sketches shew that it was not till after designing a great variety of arrangements that he fixed on the Panopticon principle on its most extensive scale, namely, a central point of observation, where the offices of the principal officers should be placed; surrounding them immediately with the businesses requiring the most constant inspection; in the next circle placing the repairs of ships; beyond them such works as required a lesser degree of observation from the superiors, but who, by means of appropriate intervals between the rays of the central building, had means of general observation from their offices, especially of the entrance-gate, and of the general landing-place. Then again, in an exterior circle, were arranged buildings such as a naval seminary, store timber houses, made mast-house, &c., which called for but little close inspection. Again, officers' dwelling-houses were designed without the boundary of the dockyard, yet so as to have a view over it. Besides this, the central observatory was raised to such a height as to afford from a terrace on the roof an uninterrupted view over the whole dockyard. By this arrangement, the several branches of business were brought, according to the degree in which they required preference, to the source of orders and instructions,—whilst the superior officers had the least possible extent of ground to pass over, when their immediate presence was required at any particular spot,—a consideration of no small importance in all great manufacturing establishments. The Admiralty, however, determined on a *partial* repair and alteration of the existing dockyard.

ROYAL INSTITUTE OF ARCHITECTS.—The first meeting of the present session will be held on Monday next, the 1st of November.

USE OF CONCRETED MASSES.

SIR,—On perusal of THE BUILDER of the 18th ult., giving copy of evidence of engineers on materials of construction for a harbour of refuge, it appears to me to shew a great want of confidence in using artificial materials, without any other grounds being set forth than want of precedent,—a course of judging that shews we have not the same spirit of invention as the original adopters of the materials in question. An examination of materials proper and most judicious, and of their application, could be made with a greater degree of truth in result, without having any recourse to precedents, which at best only shew we want confidence in our own abilities or judgment, and wish to rely on those who, ages back, with enterprize and knowledge from nature, as it were, claim our admission of their superior skill. They, as original adopters, combiners, or manufacturers of materials, had no precedent, and I think we want none,—we have nature for our guide. We can observe that all hard non-absorbent materials, as flint, granite, metals, &c., are durable in resisting compression and fretting of water; we observe all absorbent materials will not stand the fretting of water, and much less compression; we observe, for cohesive strength, materials of the greatest density are the strongest. Thus pine, less than oak; oak less that metal. In fibre we also find a great variety of drawing tenacity, independent of density. We observe for bearing, cohesive laminated materials of the greatest density are the strongest. By comparison of weight or specific gravity, of absorption, of the action of temperature, moisture, and *local* chemicals, we can ascertain materials most suitable for purposes to which we require their application. By investigation, we discover their formation by nature, and therefrom, ordinary talent, properly directed, is able to form artificial materials: we cannot do better than follow nature as our guide. Observation will inform us that all materials not subject to corrosion are durable, according to their density and non-absorbent qualities. The great natural agents of production, formation, preservation, and the reverse, are moisture and temperature; those agents are within our grasp in formation or combination of what we term artificial materials.

The evidence referred to clearly shews that brickwork in the locality is fretted away by the action of water; that concrete, in much more placid water, is eroded or worn away, and that, in its manufacture, there are no settled quantities of its ingredients. Granite and other natural stone is too expensive.

Brickwork is absorbent, and easy of abrasion or fretting by other substances, and especially water.

Concrete, by wet and dry, for want of density and adhesiveness of its components, erodes away.

As regards quantity of lime necessary to make good concrete, that quantity that will cover every portion with the thinest lamina filling the smallest interstices, is the proper quantity; all limes in setting shrink by the expelling of moisture, and therefore the thinner the lamina the better. Now as quantity of surface differs according to the gauge or mesh of the materials to be covered, so should the quantity of lime be varied; for example, suppose we have 100 perfect cubes 4 inches square each, packed together, and it takes to cover the surfaces in connection one pint of varnish, it will take much more for the same bulk if the cubes are only 2 inches square, and much more than this again if the cubes are only 1 inch square. Now the sand and shingle, composing concrete, frequently differ as much as the 4-inch and 2-inch cubes, and sometimes as much as the 1-inch and the 4-inch, yet few observe by a comparison of difference of surface any necessity for varying the quantity of lime to the extent it is absolutely necessary; but there are proofs that better concrete is at times made of 1-12th lime than in other instances of 1-5th lime.

With respect to the evidence as to the vertical *versus* the sloping or inclined surface against the sea.

Water in motion is a power in some directions almost incalculable; a drop of rain falling, has a power few observe minutely.

The oyster is supposed or is known, to

* These letters are republished in the second volume of Mr. Bowring's edition of Jeremy Bentham's works.